# Learning Analytics Dashboard for Teaching with Twitter

Anatoliy Gruzd
Ted Rogers School of Management
Social Media Lab, Ryerson University
Toronto, Canada
gruzd@ryerson.ca

Nadia Conroy
Ted Rogers School of Management
Social Media Lab, Ryerson University
Toronto, Canada
nadia.k.conroy@gmail.com

## Abstract

*As social media takes root in our society, more University instructors are incorporating platforms like Twitter into their classroom. However, few of the current Learning Analytics (LA) systems process social media data for instructional interventions and evaluation. As a result, instructors who are using social media cannot easily assess their students' learning progress or use the data to adjust their lessons in real time. We surveyed 54 university instructors to better understand how they use social media in the classroom; we then used these results to design and evaluate our own Twitter-centric LA dashboard. The overarching goals for this project were to 1) assist instructors in determining whether their particular use of Twitter met their teaching objectives, and 2) help system designers navigate the nuance of designing LA dashboards for social media platforms.*

## 1. Introduction

Social media can be a great tool to support teaching and learning [25, 32]. However, educators need to determine whether their use of social media in the classroom is beneficial to students and meets their teaching objectives. One potential way to address this issue is the use of Learning Analytics (LA) dashboards. LA dashboards can be used to help instructors notice students' learning behaviors, intervene in collaborative learning through improved awareness, and foster student participation [4, 30].

To date, much of the existing literature has focused on more traditional learning platforms with student-only access. For example, a system may show the average time spent on assignments for students enrolled in a course, or predict students' final performance based on their discussion participation. However, social media provides a more open environment for individuals to communicate, and this communication can be harnessed to assess learning. Studies on the use of social media platforms have found that they may be helpful in enriching learning by supporting the development and maintenance of close and weak social ties in communication networks, improving engagement, and creating personalized learning environments [7]. Twitter is a particularly rich platform to support learning-related interactions, such as sending questions to peers, sharing useful resources, and engaging with other students. In practice, both students and instructors have noted Twitter's impact on collaborative learning and reflection [33]. By examining Twitter posts, also known as *tweets*, we can identify what topics students are interested in based on what they are discussing, and the sentiments they express about these topics. This, in turn, may help to gauge potential understandings, frustrations, or even boredom that students might have about class-related content.

The objective of this research is two-fold: 1) to determine how Twitter can support teaching and learning; and 2) to develop a Twitter-based learning analytics dashboard.

To guide this process, we pose the following research questions:

RQ1: How is Twitter being used to support teaching and learning by university instructors?

RQ2: What are the common assessment strategies used by instructors who use Twitter for teaching?

RQ3: What analytical techniques would instructors like to see in an LA dashboard to support their assessment of Twitter-facilitated discussions?

This paper begins with a literature review situated at the intersection of social media and teaching, followed by a summative and critical analysis of previous dashboard designs. We then present the findings of an online survey administered to higher education educators about their use of Twitter in the classroom. Next, building on the literature review and the results of the survey, the paper provides a systematic design process of our own LA dashboard. Finally, we describe the results of the evaluation of the proposed dashboard by instructors who used it over the course of a semester. We highlight the benefits and drawbacks of the current design, as well as recommendations for future improvements.

URI: https://hdl.handle.net/10125/64072
978-0-9981331-3-3

## 2. Literature review

### 2.1. Twitter in the classroom

This section presents recent findings that have explored aspects of Twitter usage in a variety of learning environments and contexts. The use of Twitter has shown to address critical aspects of teaching practice, such as facilitating communication, managing collaboration, assessing students, and professional development [31]. Twitter can be used to promote learner-to-learner, and instructor-to-learner interactions, by disseminating course content and updating students about professional information. Furthermore, using Twitter for class-wide communication has been shown to increase student engagement and academic achievement [18]. However, it is important to acknowledge the practical challenges of adopting Twitter as a pedagogical tool. For instance, it can be difficult to garner participation from students due to unfamiliarity with using the tool and its purpose in academic work. Instructors may also encounter privacy concerns and imbalanced contribution from students [32]. Previous studies have recognized the importance of providing a framework of participation – such as examples of quality engagement – and motivation, such as rewarding participation grades. This allows students to recognize the potential benefits of Twitter both in terms of academic goals, and as a tool of professional development [5].

Twitter also facilitates student collaboration, as students can share useful content and bring value to the learning environment. Several studies have noted the affordance of communication facilitated through the use of the hashtag feature of the platform [10]. Through a specific course hashtag, instructors and students in a course can interact freely, allowing them to connect and collect information within the Twitter environment. Collecting Twitter content under the class hashtag gives instructors access to their students' history of learning progress. For example, instructors can track students' suggestions on other individuals' contributions, and their participation in backchannel dialogue related to class lectures and activities. Moreover, Twitter use has been found useful both for higher-order thinking tasks such as critiquing others' work and designs, and as a way of coordinating collaborative plans, such as time management and group formation [31]. Being able to coordinate work in groups has measurable effects in learning outcomes as well. In research involving domains such teacher training and graduate pharmacy education, student evaluation results show that when students complete group assignments by compiling resources from Twitter feeds, their average grade performance increased [7].

Finally, Twitter can serve as an in-class assessment tool; for example, instructors can pose questions related to the class content for students to respond to. Twitter can be incorporated into learning designs that improve student concentration and participation in class, and results in improved student exam performance [21]. However, part of the learning design should address motivation: students' attitudes and motivation to participate in class via social media are impacted when they find communicating online to be difficult.

In sum, although the existing literature has found that Twitter can be a beneficial teaching tool, there has been little investigation on how best to incorporate social media data into learning analytics. One way is using information dashboards which can improve the ability of instructors to understand learning behaviors and interactions.

### 2.2. LA dashboards

Information dashboards are visual interfaces that incorporate analytics and multiple data sources, giving the human user better visual processing, decision making, and awareness. Information dashboards have been widely adopted and used by professionals in various areas, including business management and finance [11], crisis management [17], urban control and law enforcement [26], and clinical practice [20]. LA dashboards are information dashboards designed to capture and visualize traces of learning activities that help aid awareness, reflection and sense-making by enabling learners to define goals and track their progress towards these goals [34].

A typical LA process starts with data collection about learners' activities in a learning environment, such as Learning Management Systems (LMS). In the analytics process, data is then preprocessed and mined using statistical, clustering and/or classification techniques. The results are then presented as a dashboard, featuring visualizations such as line and bar graphs, data tables, and pie charts, or more complex network visualizations and integrated displays [8]. Over time, the development of dashboards has progressed to increasingly sophisticated designs that integrate multiple data sources.

An early example of an LA dashboard is the Student Inspector [29] which uses components such as a browser to explore data, and an admin module to manage student groups. It tracks individual and group test and exercise scores and has a machine learning-based analyzer to perform more sophisticated data processing such as predicting student performance. The evaluation of this early system points to the need to reduce system complexity and unnecessary features to improve usability.

A more recent example is the Learning Object Context Ontology (LOCO)-Analyst system [1] which provides educators with feedback regarding activities completed by students. The system relies on semantic technology to interlink learning context data from different learning environments, such as chat and discussion forums. The aim is to give information about student's learning and to identify difficult topics. Participants found the system's distinguishing features to be the graphical presentation of students' interactions and ontology tags, capable of boosting and facilitating insights, and amplifying the instructors' ability to acquire knowledge to apply in their teaching.

Course Signals [2] was developed to provide real-time feedback to instructors and learners. It predicts overall performance based on students' grades, demographics, academic history, and data from LMS. Similar to the Student Inspector, Course Signals relies on data mining to determine if students are at risk of academic failure. This system was considered helpful overall, however, students found that instructor interventions in the form of numerous negative emails were difficult to cope with.

Various visualizations are used in LA systems, aiming to provide both instructors and students rapid inferences and awareness. The Student Activity Meter application [12] is designed to aid self-reflection and awareness for teachers and learners. The interface includes a variety of visualizations, including line graphs, parallel coordinates and bar charts. Other systems such as VisCa [23] have made use of innovative color-coding techniques by relying on "heatmap" representations for the level of engagement and time spent. The goal in using this technique is to help identify those individuals who are performing within a certain threshold, and to facilitate exploration and sense-making in an easy to use interface while being flexible enough to use across various course designs.

There are also several more specialized systems that support and visualize specific class activities such as real-time backchannel communication during a lecture or asynchronous online discussions. Backchannels are programs designed to support non-disruptive information and communication exchanges among audience members during an ongoing presentation by a speaker. Backstage [28] is an example of a backchannel system designed to increase student engagement, especially during large classes. This system integrates microblogging summarization for students to share their opinions and annotate lecture slides. Its main feature is an Activity Aggregator to help visualize (via parallel coordinates) the activities and ratings of students' microblogs. An affordance of such visualization is that it can help educators assess if and how students attend to the messages of others, ultimately supporting knowledge creation [22].

Unlike Backstage, systems such as Cohere [35], Wikiglass [16], and Social Networks Adapting Pedagogical Practice (SNAPP) [6] are dashboards designed to visualize and support decision making processes by students and teachers involved in online asynchronous discussions. Cohere visualizes topics in discussions through Concept Mapping, a network-type representation showing relatedness between terms mined from discussion threads. Users can then filter main terms to find clusters of related topics for further investigation. The Wikiglass LA dashboard looks at page content and revision history on a Chinese wiki platform and monitors collaboration via wiki revision counts. A directed network visualization illustrates the collaborative relationships between students, and assist with identifying active and inactive students. In the case of SNAPP, it is integrated within LMS to visualize threaded discussions and emerging student-to-student and student-to-facilitator communicative networks. Although the network visualization provides class facilitators with a social interaction diagnostic instrument from large data sets, it still requires literacy in social network analysis in interpreting the results [24].

## 3. Instructors' survey

### 3.1. Survey design and recruitment

To inform our design process, we first conducted an online survey to assess the experiences of instructors using Twitter in teaching activities. We designed our survey to gather information about university instructors' use of Twitter in teaching. The first section of the survey asked participants about course details, such as the subject area, whether they were teaching a required course, and enrollment numbers. Then we asked instructors if they had previously used Twitter in the classroom, what their objectives were in using Twitter, and whether those objectives were met. We also asked about the institution in which the course was taught, and the degree of support provided to faculty who adopted social media. The survey concluded with questions of whether instructors saw any benefits of using LA techniques to assess students' engagement on Twitter, and if yes, what types of analytics they might find useful to support their assessment. Finally, we asked instructors if they would be willing to further contribute to the study by helping us evaluate an original LA dashboard during Phase 2 of the study.

The survey questions were designed based on our previous survey design on how higher education instructors use social media more broadly [14]. We

deployed the survey in 2017 following the University ethics review. As an incentive for completing the survey, respondents were invited to enter a draw for a Google Chromecast.

To recruit study participants, we invited university instructors who are active on Twitter (identified through manual searches of public Twitter profiles). We also contacted 150 Teaching & Learning Centers at major Universities in Canada and the USA via email, asking them to disseminate our study invitation to their faculty members via mailing lists.

### 3.2. Survey results

After removing partial responses, 54 people took part in the survey between July 22, 2017 and September 30, 2017. Table 1 summarizes their demographic characteristics.

**Table 1. Demographics of study participants**

| **Institution** | **N=54** | **Percent** |
|---|---|---|
| Mostly undergraduate | 35 | 65% |
| Master's and PhD | 11 | 20% |
| Master's only | 6 | 11% |
| Community college | 2 | 4% |
| **Country** | **N=54** | **Percent** |
| Canada | 30 | 56% |
| USA | 16 | 30% |
| UK | 2 | 4% |
| Australia | 2 | 4% |
| Other | 3 | 6% |
| **Field** | **N=54** | **Percent** |
| Journalism, media studies and communication | 15 | 28% |
| Education | 11 | 20% |
| Business | 6 | 11% |
| Social sciences | 5 | 9% |
| Humanities | 2 | 4% |
| Sociology | 2 | 4% |
| Other | 13 | 24% |
| **Age** | **N=49** | |
| Min | 27 | |
| Max | 62 | |
| Median | 38 (SD:9.5) | |
| **Years Teaching** | | |
| Min | 1 | |
| Max | 38 | |
| Median | 10 (SD:6.9) | |

Most of the instructors used Twitter as a learning tool in their undergraduate-level classes ($N = 35$, 65%). Participants were also asked to specify what exactly was the purpose of their Twitter use in the classroom. Figure 1 lists the most common practices of using Twitter. The most common practice was to engage students with outside resources ($N = 38$, 20%), followed by discovering useful resources ($N = 32$, 17%), and facilitating engagement and discussion among students ($N = 32$, 17%). Some additional open-ended responses show novel uses of Twitter including using it as a data collection tool to teach analytics, or help design social media campaigns, and even educate pre-service teachers.

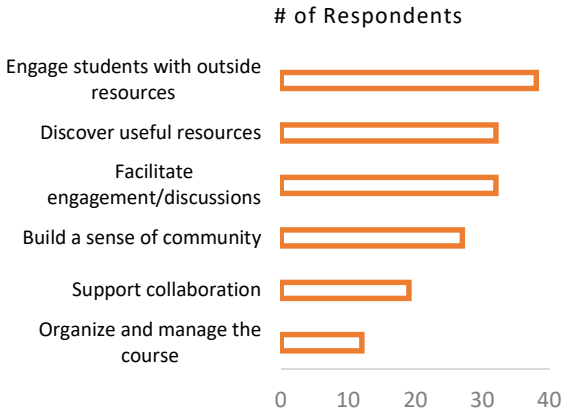


**Figure 1. Twitter use in past teaching practice**

We also asked instructors what objectives they hope to achieve using Twitter in the future. The three most cited future objectives are: 'Expose students to practice' ($N = 37$, 30%), 'Extend the range of the learning environment' ($N = 37$, 30%), and 'Promote learning through collaboration' ($N = 34$, 27%). These results align with the previous work examining the use of social media in teaching, where researchers have found that factors such as facilitating student interaction, engagement with outside resources, and enhancing student attention to content were also among the main objectives [9].

Instructors overwhelmingly ($N = 47$, 87%) reported that they were able to meet their teaching objectives. However, when instructors were not able to meet objectives (13%) they attributed this to students' reluctance to participate and their unfamiliarity with the platform.

Students' contributions were reported to also evolve over time, moving from passive to more active engagement as they became more familiar with Twitter. One respondent reported that gradually, with careful scaffolding of conversations, many students began to engage in deeper conversations and to share resources that they had independently found.

Finally, we asked instructors for their feedback on if and what analytics would help their teaching activities with Twitter. In general, answers deviated from the use of quantitative metrics. Rather than utilizing tools to automate data analysis, many respondents wanted to evaluate their students' contributions and progress by qualitatively assessing their tweets. A small number of instructors preferred to see visual reports and quantitative data about activities such as the number of replies and posting frequencies.

The next section presents our iterative design process and the resulting dashboard prototype, informed by both the information gathered in the instructors' survey and the existing literature. First, we describe the design criteria we used, primarily focusing on the usability and usefulness of the system. We then outline the design process itself and the rationale for specific visualization types, as well as provide a description of the dashboard interface and the various visualizations included. Finally, we describe the backend of the system which performs Twitter data collection and analysis.

# 4. Designing an LA dashboard

## 4.1. Design principles

As with previous dashboards [29], our goal is to help facilitate awareness and cognitive assessments of the data. To achieve this, we first consider the requirements expressed by our survey participants. Our design process is also guided by common design principles:

1. *Usability*: Create a simple, user-friendly interface in accordance with instructors' expectations for what constitutes appropriate visualizations.

2. *Usefulness*: Offer relevant and meaningful signals that can help instructors gain insight in the learning behavior of their students and support them in situated awareness and decision making.

In addition to the two main design criteria, we adapted the following architectural design principles. The first is *extensibility*. We allow for an incremental extension of functionality to accommodate different types of content without rewriting code. This means that regardless of whether students share personal opinions, links to outside content, or use hashtags, the tool should be flexible and easily adapted to manage different content types. However, we distinguish this category from interoperability with other data sources. The current version of the dashboard is designed to manage data from the Twitter platform specifically, and is not intended to be interoperable with other data sources at this point. In future designs, we intend to incorporate other data sources as well.

The second design principle is *real-time operation*. We ensure the dashboard can return current data to support "just-in-time reflections" [37], and allow for timely intervention based on newly arriving data.

The third is *privacy by design*. Privacy is a major concern, and the main reason as to why students in the past have expressed preference for Facebook over Twitter, and why teachers take efforts to educate student about appropriate behaviors in the digital world [32]. We, therefore, ensure to not disclose personal information, and use only publicly available data. With all these aforementioned guidelines in mind, we set about formulating a prototype through an iterative process of implementing and testing visualizations.

Some instructors specified a need to perform qualitative assessments of tweets, in order to make their own judgments about students' performance. A key aspect of our design, therefore, is to provide the option of allowing instructors to see the raw Twitter content, and complement that qualitative content with quantitative summaries. We used automated techniques from Natural Language Processing as a way of 'mimicking' forms of qualitative analysis. In addition, subjectivity and sentiment analysis was undertaken to provide instructors with a synopsis of the emotional polarity and factuality of tweets.

As a design methodology for certain components of our prototype, we used a method of "speculative design". The concept is based on presenting alternative visions and scenarios through the use of conceptual designs. Within speculative design, prototypes are employed as tools to allow researchers to address complex design problems, and to raise potentially contentious "what if" questions: "What if there should be a change? What if things were different?" [3]. By asking such questions, we can explore otherwise hidden cognitive processes and expectations. As part of our speculative design process we also examine values. The purpose of considering values is to design systems that better incorporate individual attitudes and standards [36]. In our case, we employ speculative design in visualizations in order to elicit instructors' reflections of what is considered appropriate for tools that examine the opinions and sentiment of student-generated content. For example, we anticipate that showing the level of negativity in online discourse and listing the top 10 posters of "negative" messages would likely elicit productive, potentially controversial, conversations about the appropriateness of certain types of analytics.

## 4.2. Data collection and analysis

The dashboard is designed to collect public tweets related to a course (based on a given hashtag), and then analyze and visualize them in a web-based application. The Twitter Streaming API was used to collect live tweets which included a specific hashtag related to a course. For example, in a sample course "LIS 2019: Information Literacy and Instruction", all tweets relating to this course could be represented by the agreed upon hashtag for the course - #LIS2019. This section describes the various components of the Dashboard's Python backend script.

Following authentication to establish a connection with the Twitter API, an instance of a stream listener is set up, which filters incoming tweets for a designated hashtag (see Figure 2). When incoming tweets match the

filter criteria, metadata fields such as user mentions, hashtags, URLs, and media are extracted and stored as properties of the recorded event. The text of the tweet is processed using the Natural Language Toolkit, which is a Python library used to assess the degree of subjectivity and sentiment in the text, as well as the presence of named entities. Subjectivity refers to whether opinionated or factual words and phrases are used; whereas sentiment refers to whether the tweets contain positive, neutral or negative affect. The resulting, enriched records are then stored in the cloud on Keen.io.

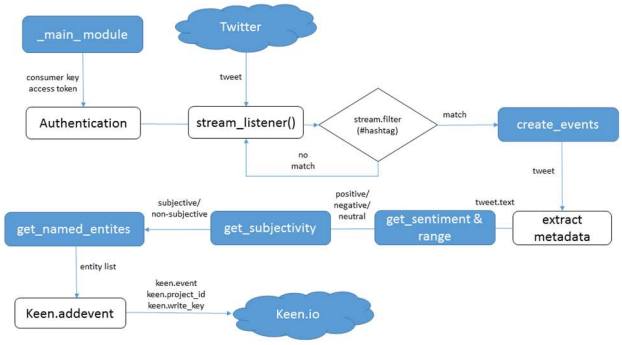


**Figure 2. Data flow**

## 4.3. User interface

The interface (Figure 3) is divided into three main sections based on different data and analytics types that are represented. Visualizations 1 to 3 in the first row labelled 'A' are charts showing the total number of tweets per day, tweets per hour, and the full content of all tweets using a course hashtag. These visualizations are included since some survey respondents expressed a preference for visual summaries of Twitter activity over time. The first two visualizations show information derived from Twitter metadata, and are designed to exhibit both an aggregated level of Twitter activities each day, as well as the times during the day that the class is most active. One survey respondent reported that access to full text would allow them to understand the students' experience with the platform, and gather suggestions on how to improve Twitter strategies in the classroom. We therefore included a Twitter timeline in visualization 3 so that instructors could explore the full context of the discussion.

Visualizations 4 to 9 in the second and third rows labelled 'B' display information about the content properties of the tweets themselves. The stacked area graph (visualization 4) is meant to represent each content type as a segment in proportion of the total number of tweets, distributed across a timeline. Stacking each segment allows for comparisons between the most common and least common content type students tend to share. As revealed in our survey, instructors aim to use Twitter in teaching as a way to facilitate discussions, as well as to engage with and introduce outside resources. It is, therefore, important that the dashboard affords instructors with the ability to make assessments on the degree to which discussion and engagement are occurring. Showing the presence of Twitter handles of class members, and the inclusion of URLs and media, means the instructor can draw inferences about both the degree of interpersonal exchanges and the capability of students to incorporate outside resources into the learning environment. For example, a high proportion of tweets with URLs might suggest that students are successfully engaging with topics by introducing external resources. Conversely, a low proportion of user mentions may suggest a lack of discussion with other users.

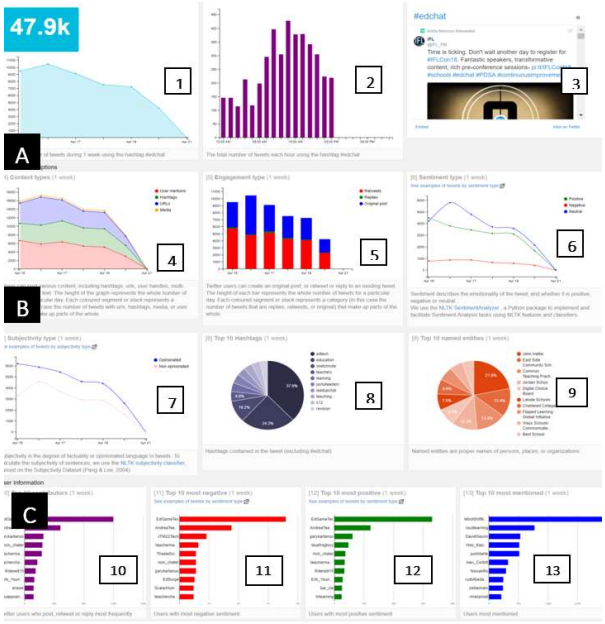


**Figure 3. LA Dashboard live prototype, showing analytics based on #edchat tweets**

Visualization 5 is a graph showing the type of tweets (retweets, replies and original tweets). This allows a visual comparison between whether students are simply redistributing others' content, if they are responding to others, or if they are creating their own original content to share. This stacked histogram format has been used to allow for quick identification of the best and worst performances – or in this case, the most and least frequent – in an aggregated view. We too strive to encourage discussions on Twitter, and look to inform instructors about the presence of lowered engagement in classes which might occur in large audiences [28]. This is important because academic engagement, or the time and effort students expend in education activities, is often linked to positive educational outcomes [19]. The

level of student engagement can then be inferred through the number of original posts and replies versus retweets. Depending on the particular use of Twitter, an instructor might want to see a higher portion of one type of post compared to another.

Visualizations 6 and 7 show the frequency of different sentiments in tweets (positive, negative, or neutral), as well as subjectivity type (opinionated, non-opinionated), plotted over a period of time. We include this as part of our speculative design to discover the value and appropriateness of examining the opinions and sentiment of student-generated content. Affective and emotional factors, among other aspects, have shown to impact students' motivation [27]. Tweets expressing negative sentiment, for example, could indicate frustration or boredom when engaging with a specific topic, whereas positive sentiment may reveal when students are excited to learn, or are encouraging each other. The presence of subjective language reveals when students tend to offer opinions on a topic, in comparison to when they are sharing factual content with the class. This difference can highlight the distinction between merely sharing data versus actively reflecting and processing concepts. Reflective learning has been an important factor in the inclusion of social media in teaching practice [14].

Visualization 8 and 9 show the most frequently included hashtags, and the most frequently referenced entities (e.g., persons, places and organizations). These two visualizations provide clues about the topical focus of tweets. In a classroom environment, increased awareness about students' learning activities and areas of difficulty makes instructors more responsive to students' needs [12]. On Twitter, the use of hashtags is typically included to help categorize the content along topical lines. Alternatively, named entities represent launching points for further discussion. Much like the inclusion of media links and URLs, the inclusion of hashtags and entities extracted from the discussion can be a sign of "reaching out" on the part of students. In this, we address instructors' expressed objective to "extend the range of the learning environment" to resources beyond the classroom.

The fourth row, labelled 'C' includes visualizations 10-13, showing a more fine-grained summary about specific users' tweets. Visualization 10 shows user handles who have produced the most tweets, visualization 11 shows the users with the highest number of negative tweets, and visualization 12 depicts the users with the highest number of positive tweets. The rationale for these visualizations is to alert instructors to students who might require intervention based on the pattern of affective properties in their communications. Having this awareness addresses the design goal of facilitating ways that instructors can intervene with students who might be experiencing specific difficulties, or conversely, encourage those students to express themselves positively.

Visualization 13 depicts the users who are most often mentioned in other tweets. From this we can provide an indication of how interactive class discussions are, which students are contributing the most, and if there are any students who are not particularly engaged with others. Promoting learning through social interaction and collaboration is largely emphasized in effective collaborative systems, as learners need to engage with others and be active in one's own learning environment [15]. Previous LA dashboards have strived to support this important need for group presence and participation. For example, previous researchers have used social networks to draw insights about relationships [24], and support real-time representations of threaded discussions and collaborative work [1]. We sought to avoid those previous designs which added visual complexity, negatively impacting usability and interaction in the discourse [35]. At the same time, we wanted to leverage the expressed support for a tool that enables connectivity and discourse in a non-linear manner.

## 5. Evaluation interviews

During the evaluation part of the study, we recruited eight instructors (three during the Fall 2017 semester, and five during the Winter 2018 semester) to use the dashboard as part of their course, and then interviewed them over Skype at the end of each semester. Each semi-structured interview took approximately 30-40 minutes to complete. We probed the users' opinions and feedback on two primary dimensions of the dashboard: 1. *Usability* (the way the design will be used and whether it enables the user to do so in a simple and effective manner), and 2. *Usefulness* (whether it allows users to accomplish their stated objectives). The interviews were guided by the following open-ended questions:

1) How did you interpret feedback provided by the LA dashboard? Please give us specific examples.
2) What actions (if any) did you take in response to analytics displayed in the LA dashboard?
3) How can we improve the assessment and visualization of the learning processes on Twitter as represented by the current version of the LA dashboard?

The evaluation protocol was first piloted with two colleagues, who were not part of the study, to identify any potential issues or shortcomings. The interviews helped us understand the usability of the proposed dashboard from the user perspective, and more importantly its potential value in assessments of

learning processes and development of possible intervention strategies.

We conducted two rounds of interviews. Following an iterative design model, the first round of interviews gave us feedback on our initial prototype. In the first design, no interface interactivity was added to keep it simple. However, the lack of interactivity with the interface was a reported downside, and users expressed how they sought to explore certain graphs but were unable to adjust the display or click on the visual elements. Instructors also wished to click on the graphs to explore more data, to visit students' user handles, and to adjust the time scales of the graphs in order to view student behaviors over the course of the semester. We used this feedback to revise our initial design. We added features to allow users to adjust the timeframe of the graphs between one week to four months, and made the visual elements clickable to view the content in more depth. In our subsequent round of interviews, instructors evaluated our second design.

Most of the instructors found the dashboard "user friendly", easy to understand, and useful. They also noted that the simplicity of the design removed the expected learning curve associated with using a new system for the first time. Respondents appreciated being able to see both class and individual student's activity at a glance by using the overall number of tweets and time of day frequency charts. In practice, instructors harnessed the benefit of Twitter in providing instant feedback over other forms of collaborative information sharing, by having students send tweets in class to generate responses to discussion topics in real time. They showed the dashboard to the class to provide feedback on incoming tweets, and for the class to see what topics were popular. Due to this form of usage, one instructor recommended adding the ability to either hide or enlarge different visualizations depending on if they are relevant to the class discussion or not.

We also explored whether the visualizations were useful in informing decisions and in-class interventions. Instructors reportedly found potential value in nearly all the visualizations. Visualizations showing most frequently occurring hashtags, named entities and the full text of tweets were the most mentioned features in our interviews. One instructor lamented that the dashboard contained an over-abundance of information which was not relevant to their teaching needs. However, for other instructors, the data was found to be useful, and used content shared by students to drive course interventions. For example, instructors would view the discussion in terms of the hashtags, named entities, and links to external content, and use that information to initiate further discussion in the class. In two cases of the dashboard used in journalism courses, students tweeted about local news organizations and about guest speakers who recently visited the class. By knowing topics that their students were interested in, instructors could prompt them to talk more in class. Another instructor used summaries of the topics mentioned in tweets as a form of grading. For example, the presence of topics not mentioned in class were indicators of "research level", since they demonstrated that students had investigated other sources on their own, and reflected and wrote about them on Twitter without specific guidance from the instructor.

According to our expectations of the speculative design scenario, our prototype did invite a range of reactions by our participants, from passing interest and curiosity, to somewhat disapproving and ambivalent. For example, when discussing the dashboard's subjectivity analysis graphs, one journalism instructor indicated that they expected strictly factual input from their students, and was not much interested in students' opinions on news articles they shared. Whereas a psychology instructor expected only opinionated reflections to articles she shared with the class. As a result, both viewed subjectivity scores of tweets to be redundant. This separation represents how subject area and pedagogical approach can influence the usefulness of the dashboard.

The inclusion of "negative" sentiment analysis (visualizations of students who most frequently posted negative content on Twitter) generated varying responses from the instructors. The use of the term "negative" was somewhat problematic, and instructors foresaw potential risks of inappropriately assigning the term to individual students. This was especially true if instructors were insufficiently informed about the limitations and purpose of sentiment classification. One limitation is that sentiment classification is divorced from context, such as the subject matter of the course. In one situation where the dashboard was used in a criminology course, pertinent topics discussed in class were often categorized as being negative, and this skewed the classification of the tweets. Also, in courses which call for a critical analysis of material, a negative expression or critique could be viewed positively. Because of this, calling attention to students with frequent negative tweets could be a misleading indicator of their actual engagement with the material.

## 6. Conclusions and future work

In this work, we strived to understand common teaching and assessment practices involving Twitter and studied how these practices may inform the design of an LA dashboard. First, we gathered opinions from instructors about how they used Twitter for teaching, and whether analytics might help them assess their use of Twitter in their teaching practice. Based on the survey

results, we found that Twitter serves as an instrument to facilitate discussion and share resources with students. We then used feedback from instructors and an examination of recent dashboard systems to create our own design and working prototype of an LA dashboard. Our resulting prototype was found by instructors to be a useful means of viewing the overall participation level of the class and providing feedback on specific topics of interest. Both quantitative and qualitative feedback on Twitter usage is important to instructors, so our design incorporated data to support both types of analyses. Our speculative use of subjectivity and sentiment classification sparked anticipated value reactions about the appropriateness of including such analysis on student-generated content.

Based on the user evaluations of our initial design, we came away with a set of features which were implemented into the second version of the LA dashboard. These changes addressed the issue of interactivity, and allowed instructors to adjust the timeframe of graphs and click on visual components to explore the content in more detail. We found that usability is largely dependent on the users' ability to explore the data and to customize the display in a way that closely corresponds to the learning design. Three instructors indicated that student evaluation and finding concrete ways to measure and differentiate student performance can be a problem when incorporating Twitter in teaching. In other words, there is often difficulty in associating students' Twitter activity over the duration of the course to some specific participation grade. To address this issue, we plan to incorporate visualizations that are oriented around specific users and groups of users. This will include providing performance indicator graphs for each student, such as posting frequently (not only the top contributors), the number of likes and retweets, hashtag usage, and posting time of day.

Although we have proposed a design that attempts to address the expressed current teaching practice of instructors, our implementation is tentative, and contingent on further evaluation and design iterations. Our goal is to facilitate teaching practice using Twitter, while gathering critical feedback on whether the design meets teaching challenges, and even whether social media is a constructive teaching tool in general.

## Acknowledgments

This work is supported in part by eCampusOntario and the Social Sciences and Humanities Research Council of Canada (PI: Anatoliy Gruzd). The authors would like to thank our study participants and members of the Social Media Lab, especially Zahra Vahedi, for their feedback on the project. An earlier version of this paper was presented at the 2018 Conference on Learning at Scale [13].

The open source code of the dashboard is available at https://github.com/RUSocialMediaLab/TwitterDashboard

## References

[1] Ali, L., M. Hatala, D. Gasevic, and J. Jovanovic, "A qualitative evaluation of evolution of a learning analytics tool", *Computers and Education 58*(1), 2011, pp. 470–489.

[2] Arnold, K.E., and M.D. Pistilli, "Course Signals at Purdue: Using Learning Analytics to Increase Student Success", *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge*, ACM (2012), pp. 267–270.

[3] Blythe, M., and E. Encinas, "Research Fiction and Thought Experiments in Design", *Foundations and Trends® Human–Computer Interaction 12*(1), 2018, pp. 1–105.

[4] Bodily, R., J. Kay, V. Aleven, et al., "Open Learner Models and Learning Analytics Dashboards: A Systematic Review", *Proceedings of the 8th International Conference on Learning Analytics and Knowledge*, ACM (2018), pp. 41–50.

[5] Chawinga, W., "Taking social media to a university classroom: teaching and learning using Twitter and blogs", *International Journal of Educational Technology in Higher Education 14*(3), 2017.

[6] Dawson, S., A. Bakharia, and E. Heathcote, "SNAPP: Realising the affordances of real-time SNA within networked learning environments", Networked Learning (2010).

[7] Desselle, S.P., "The Use of Twitter to Facilitate Engagement and Reflection in a Constructionist Learning Environment", *Currents in Pharmacy Teaching and Learning 9*(2), 2017, pp. 185–194.

[8] Dyckhoff, A.L., D. Zielke, M. Bültmann, M.A. Chatti, and U. Schroeder, "Design and Implementation of a Learning Analytics Toolkit for Teachers", *Educational Technology & Society 15*(3), 2012, pp. 58–76.

[9] Esteve Del Valle, M., A. Gruzd, C. Haythornthwaite, D. Paulin, and S. Gilbert, "Social Media in Educational Practice: Faculty Present and Future Use of Social Media in Teaching", *Proceedings of the 50th Hawaii International Conference on System Sciences*, (2017).

[10] Evans, C., "Twitter for teaching: Can social media be used to enhance the process of learning?", *British Journal of Educational Technology 45*(5), 2014, pp. 902–915.

[11] Flood, M.D., V.L. Lemieux, M. Varga, and B. Wong, "The application of visual analytics to financial stability monitoring.", *Journal of Financial Stability 27*, 2016, pp. 180–197.

[12] Govaerts, S., K. Verbert, E. Duval, and A. Pardo, "The Student Activity Meter for Awareness and Self-reflection", *CHI '12 Extended Abstracts on Human Factors in Computing Systems*, ACM (2012), 869–884.

[13] Gruzd, A., and N. Conroy, "Designing a Learning Analytics Dashboard for Twitter-facilitated Teaching",

*Proceedings of the Fifth Annual ACM Conference on Learning at Scale*, ACM (2018), 46:1–46:4.
[14] Gruzd, A., C. Haythornthwaite, D. Paulin, S. Gilbert, and M.E. del Valle, "Uses and Gratifications factors for social media use in teaching: Instructors' perspectives", *New Media & Society 20*(2), 2018, pp. 475–494.
[15] Gruzd, A., D. Paulin, and C. Haythornthwaite, "Analyzing Social Media and Learning Through Content And Social Network Analysis: A Faceted Methodological Approach", *Journal of Learning Analytics 3*(3), 2016, pp. 46–71.
[16] Hu, X., C. Yang, C. Qiao, X. Lu, and S.K.W. Chu, "New Features in Wikiglass, a Learning Analytic Tool for Visualizing Collaborative Work on Wikis", *Proceedings of the Seventh International Learning Analytics & Knowledge Conference*, ACM (2017), 616–617.
[17] Irtaimeh, H.J., A.M.A. Obaidat, and A.A.H. Khaddam, "Strategic Role of Dashboard Application in Enhancing Crisis Management Capabilities in Organizations Field Study on Jordanian Cellular Companies.", *International Journal of Management Sciences and Business Research 5*(10), 2016.
[18] Junco, R., C.M. Elavsky, and G. Heiberger, "Putting Twitter to the Test: Assessing Outcomes for Student Collaboration, Engagement and Success.", *British Journal of Educational Technology*, 2012.
[19] Junco, R., G. Heiberger, and E. Loken, "The effect of Twitter on college student engagement and grades", *Journal of Computer Assisted Learning 27*(2), 2011, pp. 119–132.
[20] Karami, M., and R. Safdari, "From Information Management to Information Visualization", *Applied Clinical Informatics 07*(2), 2016, pp. 308–329.
[21] Kim, Y., S. Jeong, Y. Ji, S. Lee, K.H. Kwon, and Jeon J. W., "Smartphone response system using twitter to enable effective interaction and improve engagement in large classroom", *IEEE Transactions on Education 58*(2), 2015, pp. 98–103.
[22] Knight, S., and K. Littleton, "Dialogue as data in learning analytics for productive educational dialogue", *Journal of Learning Analytics 2*(3), 2016, pp. 111–143.
[23] Lin, C.-H., S.-S. Hu, H.-Y. Lai, C.-F. Chiang, H.-C. Tseng, and Y.-C. Cheng, "VisCa: A Dashboard System to Visualize Learning Activities from E-learning Platforms", *Emerging Technologies for Education*, Springer International Publishing (2017), 422–427.
[24] Lockyer, L., E. Heathcote, and S. Dawson, "Informing Pedagogical Action: Aligning Learning Analytics with Learning Design", *American Behavioral Scientist 57*(12), 2016, pp. 1439–1459.
[25] Luo, T., S.J. Shah, and H. Cromptom, "Using Twitter to Support Reflective Learning in an Asynchronous Online Course", *Australasian Journal of Educational Technology*, 2019.
[26] McArdle, G., and R. Kitchin, "The Dublin Dashboard: Design and Development of a Real-Time Analytical Urban Dashboard", *ISPRS Annals of Photogrammetry, Remote Sensing and Spatial Information Sciences*, Copernicus GmbH (2016), 19–25.
[27] Ortigosa, A., J.M. Martin, and R.M. Carro, "Sentiment analysis in Facebook and its application to e-learning", *Computers in Human Behavior 31*, 2014, pp. 527–541.
[28] Pohl, A., F. Bry, J. Schwarz, and M. Gottstein, "Sensing the classroom: Improving awareness and self-awareness of students in Backstage", *The 15th International Conference on Interactive Collaborative Learning (ICL)*, (2012), 1–8.
[29] Scheu, O., and C. Zinn, "How did the e-learning session go? The student inspector", *The 13th International Conference on Artificial Intelligence and Education (AIED 2007)*, IOS Press (2007).
[30] Sedrakyan, G., J. Malmberg, K. Verbert, S. Järvelä, and P.A. Kirschner, "Linking learning behavior analytics and learning science concepts: Designing a learning analytics dashboard for feedback to support learning regulation", *Computers in Human Behavior*, 2018.
[31] Sharp, L.A., "Twitter as a Technology Tool to Elicit Deeper Levels of Understanding among Adult Learners", *Journal of Literacy and Technology 18*(3), 2017, pp. 56–84.
[32] Tang, Y., and K.F. Hew, "Using Twitter for education: Beneficial or simply a waste of time?", *Computers & Education 106*, 2017, pp. 97–118.
[33] Tur, G., V. Marinn, and J. Carpenter, "Using Twitter in Higher Education in Spain and the USA", *Media Education Research Journal 25*(51), 2017, pp. 19–27.
[34] Verbert, K., S. Govaerts, E. Duval, et al., "Learning Dashboards: An Overview and Future Research Opportunities", *Personal Ubiquitous Comput. 18*(6), 2014, pp. 1499–1514.
[35] Vovides, Y., and S. Inman, "Elusive Learning—Using Learning Analytics to Support Reflective Sensemaking of Ill-Structured Ethical Problems: A Learner-Managed Dashboard Solution.", *Future Internet 8*(2), 2017.
[36] Wong, R.Y., D.K. Mulligan, E. Van Wyk, J. Pierce, and J. Chuang, "Eliciting Values Reflections by Engaging Privacy Futures Using Design Workbooks", *Proceedings of the ACM on Human Computer Interaction 1*(2), 2017.
[37] Wright, N., "Twittering in teacher education: Reflecting on practicum experiences", *Open Learning 25*(3), 2010, pp. 259–265.